In 2000, apart from Golianovo, a circle (single, diameter to 40 m) appeared also in the Lapáš district. It is located to the northwest of the rondel in Golianovo, in a distance of 3 km, i.e. the same distance as the circle ditch in Veľký Cetín, which lies to the southwest. In contrast to that ditch, a straight visual contact with the circle in Lapáš is not possible. Although we do not know the date of either of the two ditch structures, it is not to be excluded that they might belong to Lengyel culture. This may be confirmed in the future. In that case, its connection to the rondel in Golianovo could be supposed, which could fulfil a central function with regard to its size. It could undoubtedly contribute to further explanations of the function and position of circular ditch systems.

References:
Kuzma, I. 1998: Kruhové priekopové útvary na Slovensku (súèasný stav). In.: Otázky neolitu a eneolitu našich zemí. Turnov-Hradec Králové 1998, 94–102.
Kuzma, I. – Kopecký, M. – Rajtár, J. 1990: Výsledky leteckej prospekcie. AVANS v r. 1988, 100–102.
Podborský, V. 1988: Tišetice-Kyjovice 4/. Rondel osady lidu s moravskou malovanou keramikou. Brno.
Tirpák, J 1993: Geophysical prospecting at three archaeological sites in Slovakia. In: Geophysical exploration of archaeological sites, Braunschweig–Wiesbaden, 315–321.

In Archaeological Prospection: 4th International Conference on Archaeological Prospection, P.M. Doneus, A. Eder-Hinterleitner, W. Neubauer, eds., Austrian Academy of Sciences Press, Vienna, pp. 141-143.

Archaeological prospecting in fortified Great Plains villages: new insights through data fusion, visualization and testing

Kenneth L. Kvamme

In a five year research-oriented program based on geophysical surveys and related methods in the Great Plains of the Dakotas, many new insights and an increased understanding of the prehistoric and historic archaeology have been gained. These projects have employed broad area magnetic gradiometry and resistance survey techniques, EM survey methods (soil conductivity and magnetic susceptibility), together with more focused studies through resistivity tomography and ground penetrating radar (GPR). Aerial photography and centimeter-level mapping of surface microtopography have also been undertaken. In each study common themes have been: (1) use of multiple geophysical survey techniques, (2) use of GIS methods to co-register individual data layers and provide an efficient data management and integration system, (3) use of advanced image processing and data visualization tools, and (4) archaeological testing of samples of anomalies for field identification or validation, frequently possible to achieve with a hand-held soil auger.

This research has been conducted for a variety of purposes, including the exploration of data fusion techniques (integrating multiple data sources) at a buried village "invisible" on the surface for the U.S. National Park Service, and a series of mappings of significant cultural features at sites in the North Dakota State Park system for the purpose of increasing tourism potential, particularly in preparation for the bicentennial (in 2004) of the Lewis and Clark Voyage of Discovery (the primary event that helped to open the Dakotas, and western North America, for settlement by Euro-Americans). Specific findings in several of the projects provide an indication of the content and promise of these projects. At the Whistling Elk site, in South Dakota, prior knowledge through a salvage excavation suggested an attack and rapid abandonment of this 14th century village. The geophysical findings reveal more details with additional burned houses and a second village with its own fortification system within the wider village, suggesting a reoccupation and village contraction. An unusually large structure, interpreted as ceremonial, was also discovered.

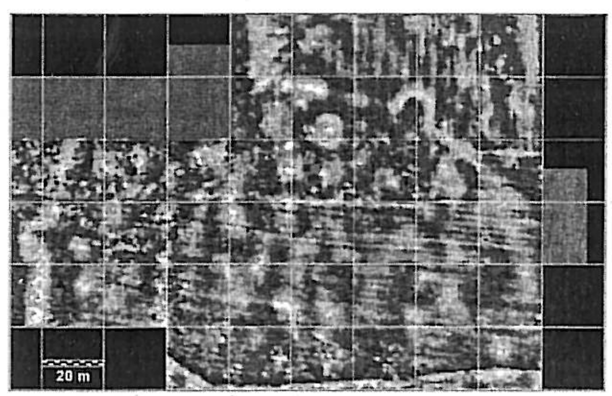

Figure 1: RGB color composite of magnetic, conductivity, and resistivity findings, respectively, showing the distribution of houses and fortification features within Whistling Elk, a 14th century village in South Dakota, USA.

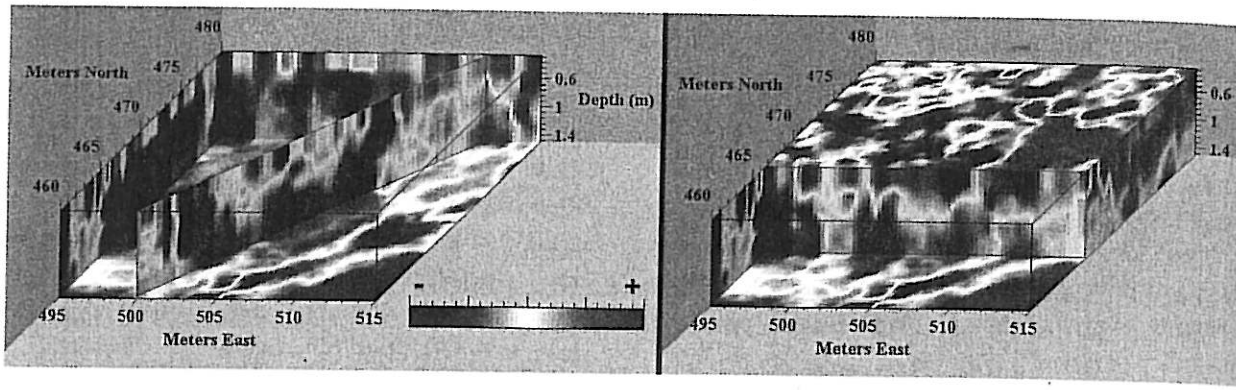

Figure 2: Resistivity tomography methods applied to a 15th century house at Huff Village, North Dakota USA, showing low resistivity above the packed earth floor and high resistivity below it.

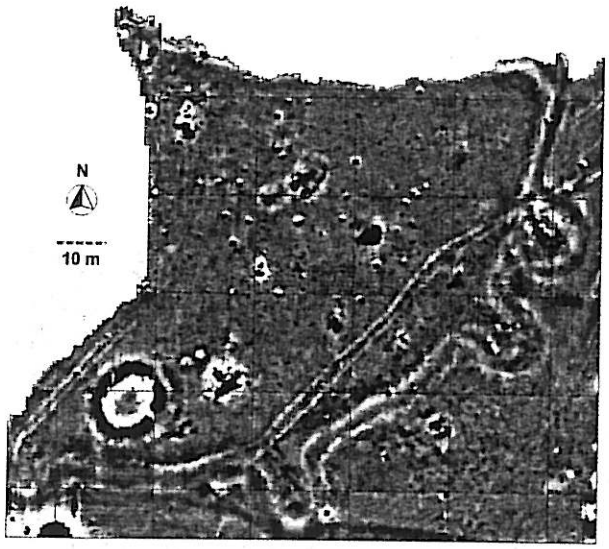

Figure 3: Magnetic gradiometry image of the early 13th century Menoken Village, North Dakota USA, showing the fortification system with bastions, burned houses, several trails, and an early, circular, unfilled excavation.

At Huff, a mid-15th century village in North Dakota, a central plaza is clearly defined and its ritual significance is underscored by a lack of features within it. The consistent shapes, sizes, and internal organization of regularly spaced houses are emphasized, as is the volume of grain storage indicated by the tremendous number of bell-shaped pit features.

At Menoken, an AD 1200's village in North Dakota, burned houses, indications of house form, and an intra-village trail network are obtained, as is information about formation processes related to the fortification system.

At *Mittuta-hang-kush*, an ethnographic Mandan-Arikara village in North Dakota (occupied from about 1822–1861), a 400 m transect reveals numerous houses seen on the surface (as shallow depressions) and in aerial photographs, but also new houses not seen and overlapping ones, suggesting the succession of occupation from Mandan to Arikara. That some houses have many iron artifacts, while others few, may point to closer trade ties or interactions with nearby posts of the American fur trade.

At Fort Clark, an 1830–1860 fur trade post near *Mittuta-hang-kush*, five geophysical techniques reveal numerous details, particularly after data fusion, including stone foundations, floors, probable areas of burning, a dumping ground, and a Euro-American cemetery.

Many positive benefits have developed from this work. General mappings and identifications of significant cultural features have been achieved within these sites, providing greater understanding of them together with important management and planning documentation.

Anomalies could frequently be culturally identified with a high degree of accuracy based on their form, content, and spatial context within the geophysical imagery. Such anomalies include houses, interior house features, grain storage bins, fortification ditches, bastion loops, trails, and village plazas. Archaeological test excavations necessary for site interpretive programs could be placed exactly over anomalies of interest. New primary data has been acquired of great importance to Great Plains archaeology, including information about village layout, fortification systems, village size, the density and number of houses (and population by inference), recognition of aspects of warfare (through fortifications and burned houses), and the volume of horticultural production (inferred by numbers of grain storage features).

North American archaeologists (generally naïve about geophysical survey capabilities) have achieved a greater awareness of geophysical remote sensing and, thanks to our generally good results, these methods are now viewed positively and are in greater demand, particularly in the Great Plains. Part of the interpretive signage now in place in North Dakota archaeological state parks includes depictions of geophysical survey results, which serves to increase public awareness and support of these methods.

Conclusions about the use of geophysical survey methods, their advantages and shortcomings, and the nature of features they are able to detect in Great Plains contexts, may also be drawn from these studies. Primary among these is the usual success of magnetic and resistance survey methods at these kinds of sites. While the former usually allows definition of trails, house features like hearths, burned roof support posts, and grain storage features, the latter tends to clearly define house outlines and exterior fortification ditches as well as trails. Part of the success of these methods is due to their ability to cover large areas in relatively short spans of time. Although the speed, large-area coverage, and high sampling density of magnetic gradiometry surveys is well-known, it is also possible to conduct rapid resistance surveys of very large areas at high spatial resolution (i.e., 50 × 50 cm) through the use of four simultaneous twin-probe readings taken in parallel at these shallow sites. Electrical resistivity and soil conductivity methods, while theoretically related, tend to produce results with enough new information (owing to very different sensing technologies) to warrant both techniques when possible. Three-dimensional visualization, including the use of animations, of multiple-depth resistivity data (resistivity tomography) and GPR output through time-slicing methods can also add important insights about the nature of complex deposits such as those that occur in the vicinity of prehistoric houses.

Advances in 3D visualization of georadar data

Jürg Leckebusch, Ronny Peikert, Markus Hauser

Ground penetrating radar or GPR provides full three-dimensional information of the sub-surface and is therefore an excellent prospection method for archaeology. Unfortunately, it is not as easy to extract the three-dimensional information from this data as it is for other geophysical prospection methods. The conventional display of profiles or time-/depth slices only represents a two-dimensional view of a selected portion of the complete dataset. If appropriate geophysical processing is applied, the whole data cube can be visualised by calculating the iso-surface for a user-selected level. The iso-surfaces are regarded as a representation of the buried structures. This will give a complete view

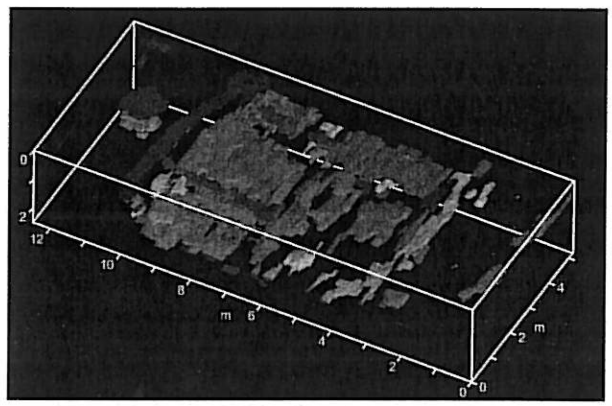

Figure 2: After an isosurface has been calculated, the volumes are colour-coded and a threshold is applied to remove small volumes of less significance.

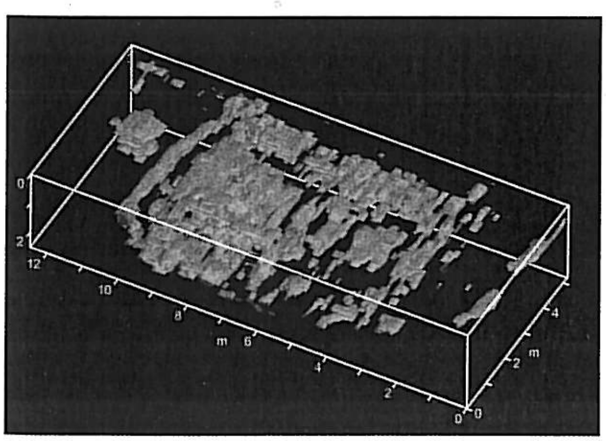

Figure 1: Three-dimensional visualization of ground penetrating radar data. Isosurface representation of a small portion of a palace from the roman town Augusta Raurica (Augst) in Switzerland.

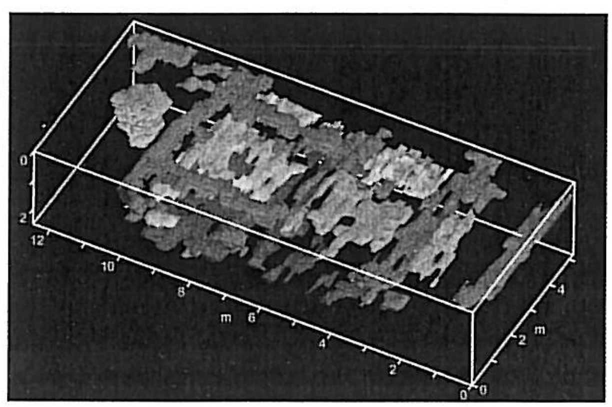

Figure 3: By using local iso-levels to the data of figure 1, a much better image can be achieved, representing the true geometry more precisely.